RuggedServer™ RS416 Family

Modular Serial Device Server with Integrated Managed Ethernet Switch

Installation Guide

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Federal Communications Commission Radio Frequency Interference Statement

This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his expense.

Caution

This product contains a laser system and is classified as a "CLASS 1 LASER PRODUCT".

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. This product contains no user-serviceable parts. Attempted service by unauthorized personnel shall render all warranties null and void.

Should this device require service see the "Warranty" section of this installation guide.

Important

This unit should be installed in a restricted access location where access can only be gained by service personnel or users who have been instructed about the reasons for the restrictions applied to the location and about any precautions that shall be taken; and access is through the use of a tool or lock and key, or other means of security, and is controlled by the authority responsible for the location.

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1 Product Overview

1.1 Functional Overview

RuggedServer™ RS416 represents a family of industrially hardened serial device servers with integrated, fully managed, Ethernet switches. The RS416 is designed to operate reliably in electrically harsh and climatically demanding environments. Featuring a modular design that can support up to 16 serial ports, up to 4 Ethernet ports, and optional IRIG-B support, the RS416 is able to interconnect multiple types of intelligent electronic devices (IEDs) that require different methods of communications. Using the RS416 results in fewer connectivity devices (which reduces overall system costs) and also extends the useful life of existing legacy IEDs (which minimizes capital expenditure for new equipment).

The RS416 provides a high level of immunity to electromagnetic interference and heavy electrical surges typical of environments found in electric utility substations, factory floors or in curb side traffic control cabinets. The RS416 meets or exceeds a wide range of industry standards including IEC 61850, IEEE 1613, IEC 61000-6-2, IEC 61800-3, and NEMA TS-2. The RS416 also features a wide operating temperature range of -40°C to +85°C allowing it to be installed in virtually any location.

For applications requiring high availability, the RS416 provides the option for integrated dual redundant power supplies, each capable of accommodating a wide range of input voltages for worldwide operability. Also unique is the ability to have each power supply fed from different voltage levels and/or sources thereby providing great flexibility in creating high availability systems. The RS416P provides IEEE 802.3af standard Power over Ethernet (PoE) on its 10/100BaseTx ports.

The embedded Rugged Operating System (ROS®) within the RS416 provides advanced layer 2 and layer 3 networking functions, advanced cyber security features, and a full array of intelligent functionality for high network availability and manageability. These features, in addition to the ruggedized hardware design, make the RS416 ideal for creating mission-critical, real-time, control applications in any harsh environment. The RS416 is also backed by RuggedCom's all inclusive five year warranty and unsurpassed technical support.

The RS416 implements both the Precision Time Protocol (PTP - IEEE 1588 v2) and IRIG-B for high-precision time synchronization across both Ethernet and legacy networks.

1.2 Feature Highlights

Serial Device Server

- Modular design allows for 4, 8, 12, or 16 serial ports
- Fully compliant EIA RS422 / TIA RS485, RS422, RS232 serial ports (software selectable)
- DB9 or RJ45 connectors
- Transmit serial data over an IP network
- Support for Modbus TCP, DNP 3, TIN serial protocols
- Baud rates up to 230 kbps
- Raw socket mode allows conversion of any serial protocol
- Point-to-point and multi-point modes
- Converts Modbus RTU to Modbus
- Supports multiple Modbus masters
- Converts DNP3.0 to DNP over UDP/TCP

Ethernet Ports

- Integrated Ethernet Switch - 2 or 4 port options - (copper and/or fiber)
- High performance, high throughput Ethernet switching
- Fully IEEE 802.3, IEEE 802.3u, IEEE 802.3x compliant
- Non-blocking, store and forward switching

Precision Time Protocol (PTP – IEEE1588v2)

- Support for IEEE 1588 v2 on all Ethernet ports
- Supports master and slave clock modes
- Accuracy on the order of 100µs

IRIG-B Ports

- Optional IRIG-B module (receive/transmit on BNC)
- Optional serial port modules for RS232, RS485, or RS422 provide IRIG-B on either DB9 or RJ45 connectors.
- IRIG-B PWM (B006 or B007) or PPS output per port, selectable via software

RuggedRated™ for Reliability in Harsh Environments

- Immunity to EMI and heavy electrical surges
- Meets IEEE 1613 (electric utility substations)
- Exceeds IEC 61850-3 (electric utility substations)
- Exceeds IEC 61800-3 (variable speed drive systems)
- Exceeds IEC 61000-6-2 (generic industrial)
- Exceeds NEMA TS-2 (traffic control equipment)
- Fully independent 2 kV (RMS) isolated serial ports
- -40°C to +85°C operating temperature (no fans)
- 18 AWG galvanized steel enclosure

Power Supply Options

- Fully integrated, dual-redundant (optional) power supplies (RS416)
- Power over Ethernet (PoE) on 10/100BaseTx ports (RS416P)
- Universal high-voltage range: 88-300 VDC or 85-264 VAC
- Popular low voltage DC ranges: 12 VDC, 24 VDC, 48 VDC

- Terminal blocks for reliable maintenance free connections
- CSA/UL 60950 safety approved to +85°C

Rugged Operating System (ROS®) Features

- Simple plug and play operation - automatic learning, negotiation, and crossover detection
- Integrated Cyber Security features
- RSTP (802.1w), Enhanced Rapid Spanning Tree (eRSTP™) network fault recovery (<5ms), and Multiple Spanning Tree (MSTP – 802.1s)
- Quality of Service (802.1p) for real-time traffic
- VLAN (802.1q) with double tagging and GVRP support
- IGMP Snooping for multicast filtering
- Port Rate Limiting and Broadcast Storm Limiting
- Port configuration, status, statistics, mirroring, security

Management Tools

- Web-based, Telnet, CLI management interfaces
- SNMP v1/v2/v3
- Remote Monitoring (RMON)
- Rich set of diagnostics with logging and alarms

1.3 Display Panel Description

The RS416 is equipped with a versatile display panel, shown in Figure 1, which is designed to provide quick status information for each port, as well as the entire device to allow for simple diagnostics and troubleshooting. It features:

- RS232 console port for 'out of band' console access and configuration
- Power supply and Alarm status indicators
- Convenient port status indicators conveying Link-Activity, Duplex, or Speed via push-button control.
- System reset via push-button if held for 5 seconds

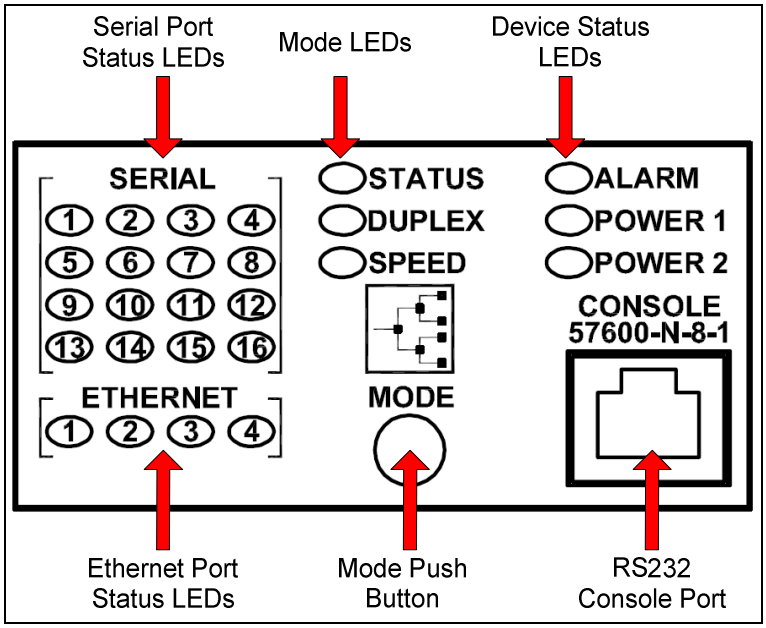


Figure 1: RS416 LED Display Panel

Device status LEDs exist to provide a quick visual indicator to operators for operational status of the unit. Table 1 defines the possible LED colors and the corresponding description.

LED	*Color*	*Description*
Power 1 / 2	Green	Power supply operating normal
	Red	Power supply failure
Alarm	Red	Alarm exist – login to console to determine alarm code
	Off	No alarms exist

Table 1: LED Display – Device status LED behavior definition

The port-based LEDs can be cycled between three display modes: Status, Duplex, and Speed. Pushing the mode button causes the display mode to be cycled. Table 2 defines the possible port LED colors and the corresponding description.

Mode	*Color*	*Ethernet Port Status LEDs*	*Serial Port Status LEDs*
Status	Green (Solid)	Link	-
	Green (Blinking)	Activity	Traffic
	Off	No link	No Traffic
Duplex	Green (Solid)	Full-Duplex	Full-Duplex
	Orange (Solid)	Half-Duplex	Half-Duplex
	Off	No link	No link
Speed	Green Blinking	-	> 57600 bps
	Green (Solid)	100Mbps	> 19200 bps, ≤ 57600 bps
	Orange (Solid)	10 Mbps	≤ 19200 bps
	Off	No link	No link

Table 2: LED Display - Port LED behavior definition

2 Installation

2.1 Mounting

The RS416 has been designed with maximum mounting and display flexibility. Customers can order an RS416 that can be mounted in a standard 19" rack, 1" DIN Rail, or directly onto a panel. For rack mount installations, the RS416 can be ordered with connectors on the front of the unit, or located on the rear of the chassis to allow for all data and power cabling to be installed and connected at the rear of the rack. See Figure 2 for rack mount orientation examples.

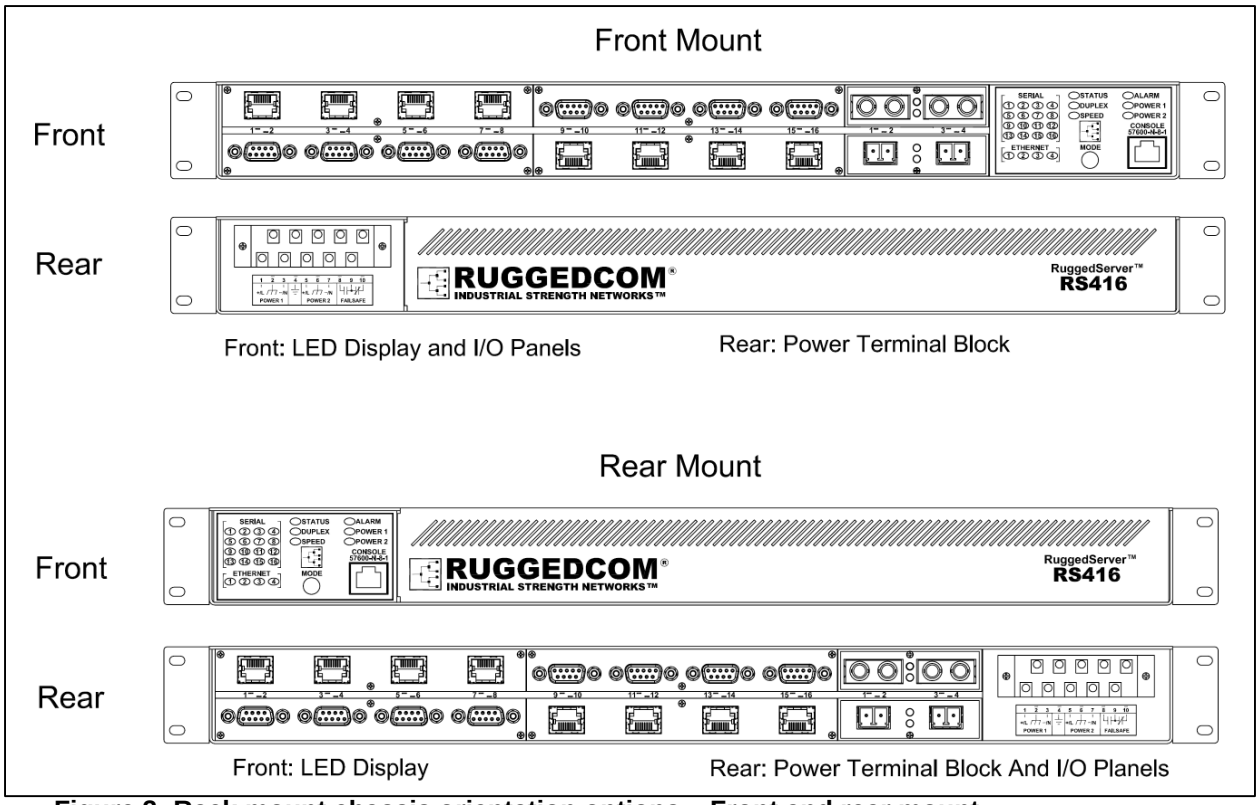


Figure 2: Rack mount chassis orientation options – Front and rear mount.

2.1.1 Rack Mounting

The RS416 can be rack mounted using the included rack mount adapter assemblies shown in Figure 3. Secure the one rack mount adapter to the front of each side of the chassis using the included black PAN head Phillips screws in the positions shown in Figure 4. The entire chassis can then be mounted to a standard 19" rack. An additional two rack mount adapters are included to optionally secure the rear of the chassis in high-vibration, or seismically active locations.

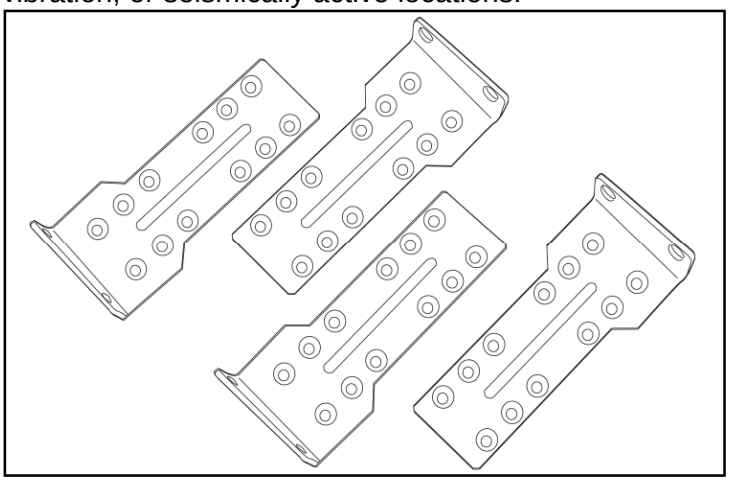


Figure 3: 19" Rack Mount Adapters

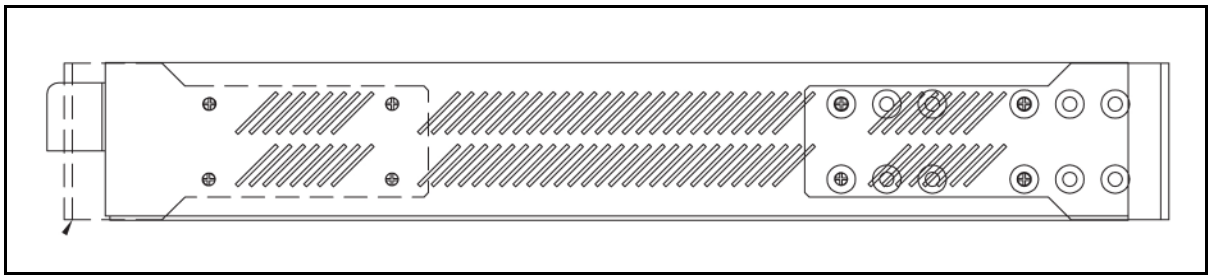


Figure 4: Rack mount adapter mounting location

NOTE: Since heat within the RS416 is channeled to the enclosure, it is recommended that 1 rack unit of space (1.75") be kept unpopulated and free of equipment above each RS416 product to allow for a small amount of convectional airflow. Although forced airflow is not necessary, any increase in airflow will result in a reduction of ambient temperature that will improve long-term reliability of all equipment mounted within the rack space.

2.1.2 Panel and DIN Rail Mounting

The RS416 can be ordered as a Panel/DIN mount chassis. Both options involve the use of the panel/DIN adapters to be mounted on each side of the chassis enclosure. The adapter allows the chassis to be mounted on the standard 1" DIN rail using the grooves in the adapter, secured using the included Phillips screw. See Figure 5 for a PANEL/DIN mount diagram.

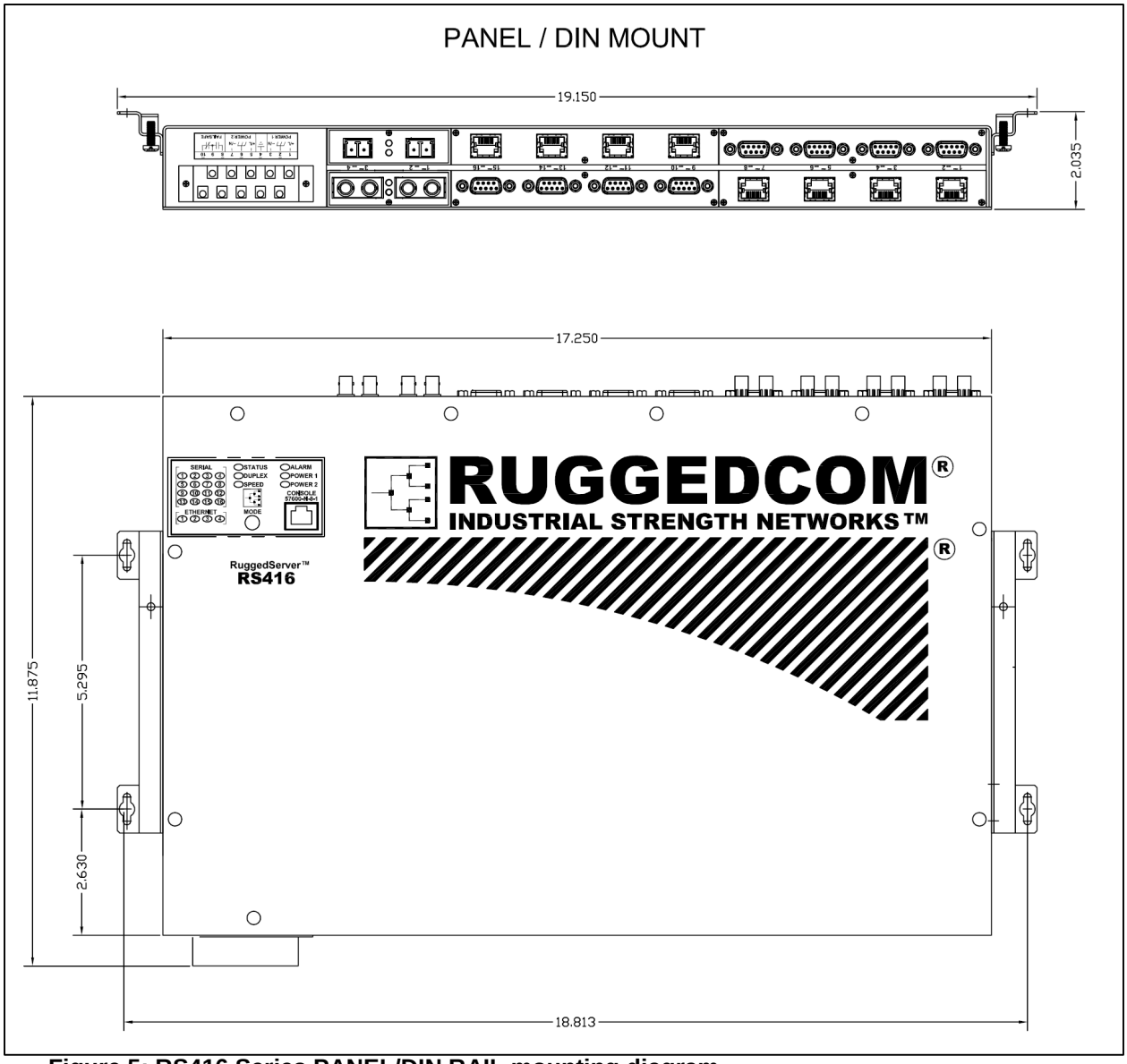


Figure 5: RS416 Series PANEL/DIN RAIL mounting diagram

2.2 Power Supply Wiring and Grounding

The RS416 supports dual redundant power supplies – "Power Supply 1 (PS1)" and "Power Supply 2 (PS2)". RS416P features a universal high voltage range power supply as PS1, and a separate 48VDC supply, PS2, to provide Power over Ethernet. The connections for PS1, PS2 and the fail-safe relay are located on the terminal block as shown in Figure 6 and Figure 7.

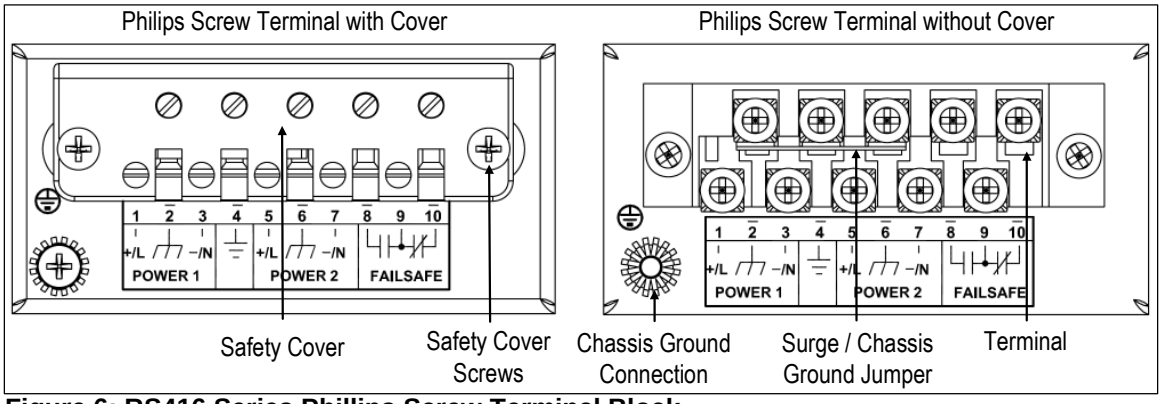


Figure 6: RS416 Series Phillips Screw Terminal Block

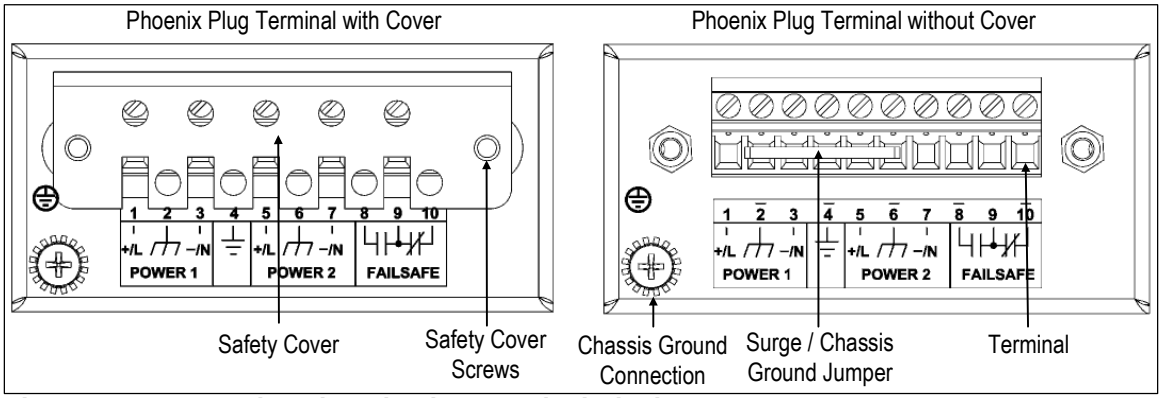


Figure 7: RS416 Series Phoenix Plug Terminal Block

The RS416 Family chassis ground connection, shown in Figure 8, uses a #6-32 screw. It is recommended to terminate the ground connection in a #6 ring lug, and to use a torque setting not exceeding 15 in.lbs (1.7 Nm).

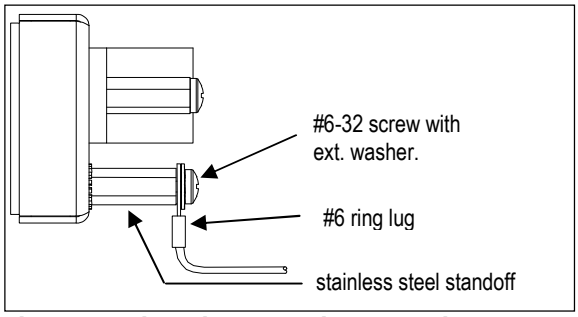


Figure 8: Chassis Ground Connection

The RS416 can be equipped with either a Phillips Screw Terminal Block or a Phoenix Plug Terminal Block. The Phillips Screw Terminal Block has Phillips screws with a

compression plate allowing either bare wire connections or crimped terminal lugs. We recommend the use of #6 size ring lugs to ensure secure, reliable connections under severe shock or vibration. Both terminal blocks have a safety cover which must be removed via two Phillips screws before connecting any wires. The safety cover must be re-attached after wiring to ensure personnel safety. Refer to Table 3 and Table 4 below for a description of each terminal as well as sections 2.2.1 through 2.2.3 for wiring examples.

Terminal #	***Description***	***Usage***
1	PS1 Live / +	**PS1 Live / +** is connected to the positive (+) terminal if the power source is DC or to the (Live) terminal if the power source is AC.
2	PS1 Surge Ground	**PS1 Surge Ground** is connected to the Chassis Ground via a jumper on the terminal block. Surge Ground is used as the ground conductor for all surge and transient suppression circuitry.
3	PS1 Neutral / -	**PS1 Neutral / -** is connected to the negative (-) terminal if the power source is DC or to the (Neutral) terminal if the power source is AC.
4	Chassis Ground	**Chassis Ground** is connected to the Safety Ground terminal for AC inputs or the equipment *ground bus* for DC inputs. Chassis ground connects to both power supply surge grounds via a removable jumper.
5	PS2 Live / +	**PS2 Live / +** is connected to the positive (+) terminal if the power source is DC or to the (Live) terminal if the power source is AC.
6	PS2 Surge Ground	**PS2 Surge Ground** is connected to the Chassis Ground via a jumper on the terminal block. Surge Ground is used as the ground conductor for all surge and transient suppression circuitry.
7	PS2 Neutral / -	**PS2 Neutral / -** is connected to the negative (-) terminal if the power source is DC or to the (Neutral) terminal if the power source is AC.
8	Relay NO Contact	Normally open, failsafe relay contact.
9	Relay Common	Failsafe relay common contact.
10	Relay NC Contact	Normally closed, failsafe relay contact.

Table 3: RS416 Power terminal block connection description

Terminal	***Description***	***Usage***
5	PS2+	**PS2+** is connected to the positive (+) terminal of a 48VDC power supply
7	PS2-	**PS2-** is connected to the negative (-) terminal of a 48VDC power supply

Table 4: RS416/RS416P power supply connection differences

2.2.1 AC Power Supply Wiring Examples

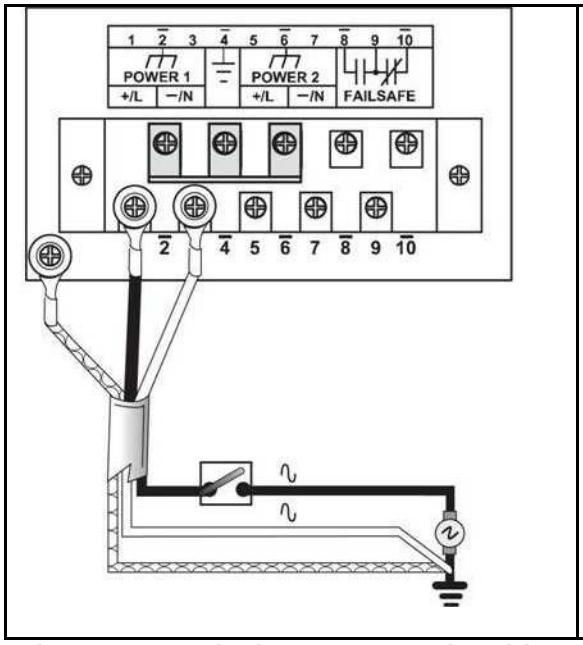


Figure 9: AC Single Power Supply Wiring Example

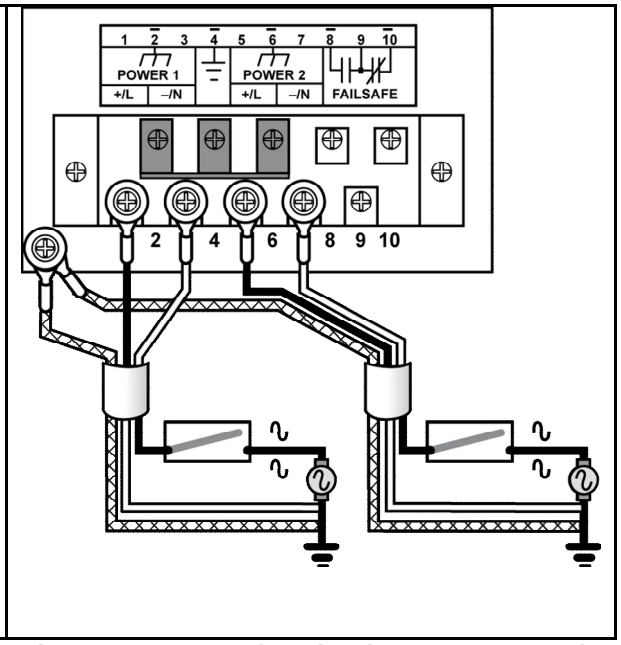


Figure 10: AC Dual Redundant Power Supply Wiring Example

NOTES:

1. 100-240VAC rated equipment: A 250VAC appropriately rated circuit breaker must be installed.
2. Equipment must be installed according to the applicable country wiring codes.
3. When equipped with two HI voltage power supplies, independent AC sources can be used to power the product for greater redundancy. However, separate circuit breakers must be installed and separately identified (not shown in above figure).

2.2.2 DC Power Supply Wiring Examples

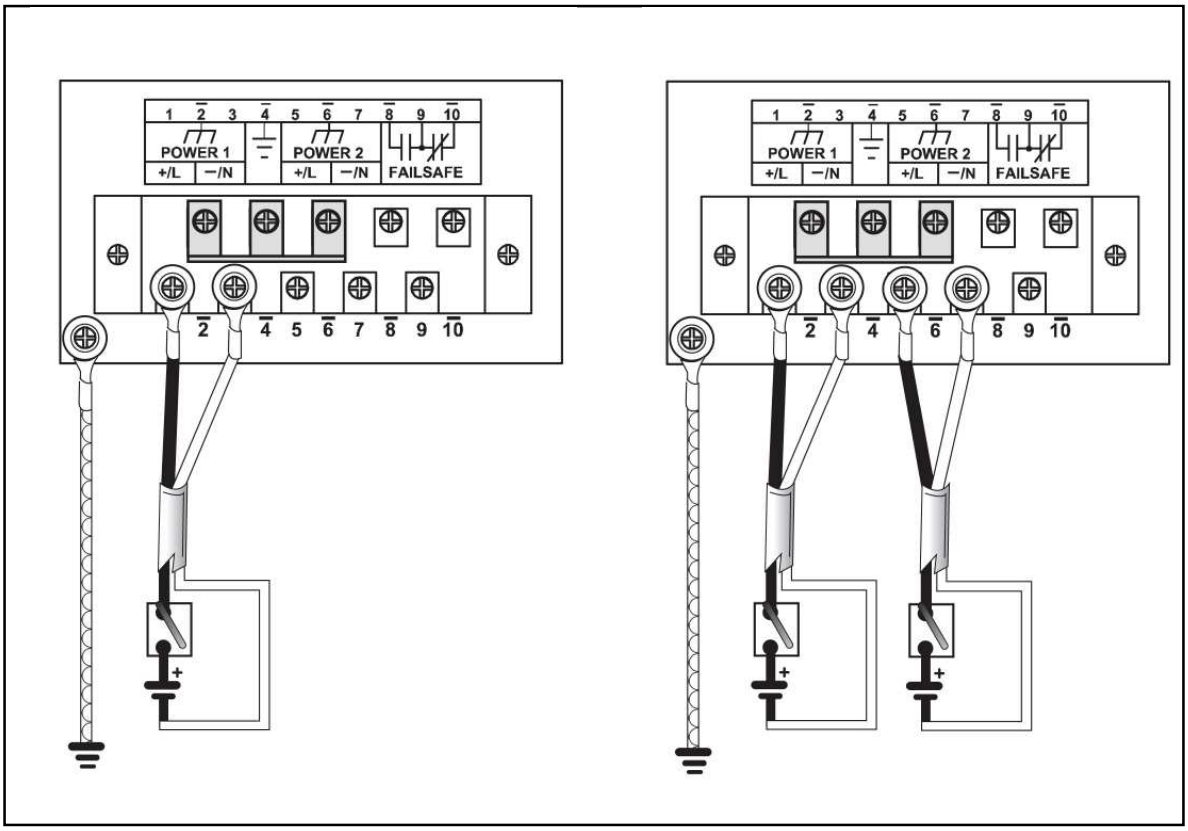


Figure 11: DC Power Supply Wiring Examples

NOTES*:*

1. 88-300VDC rated equipment: A 300VDC appropriately rated circuit breaker must be installed.
2. A circuit breaker is not required for 12, 24 or 48 VDC rated power supplies.
3. Equipment must be installed according to the applicable country wiring codes.
4. When equipped with two HI voltage power supplies, independent AC sources can be used to power the product for greater redundancy. However, separate circuit breakers must be installed and separately identified.
5. When equipped with two DC voltage power supplies (88-300VDC rated); independent DC sources may be used to power the product for greater redundancy. However, separate circuit breakers must be installed and separately identified (as shown in the above figure).

2.2.3 Dual Power Supplies – DC and AC Inputs

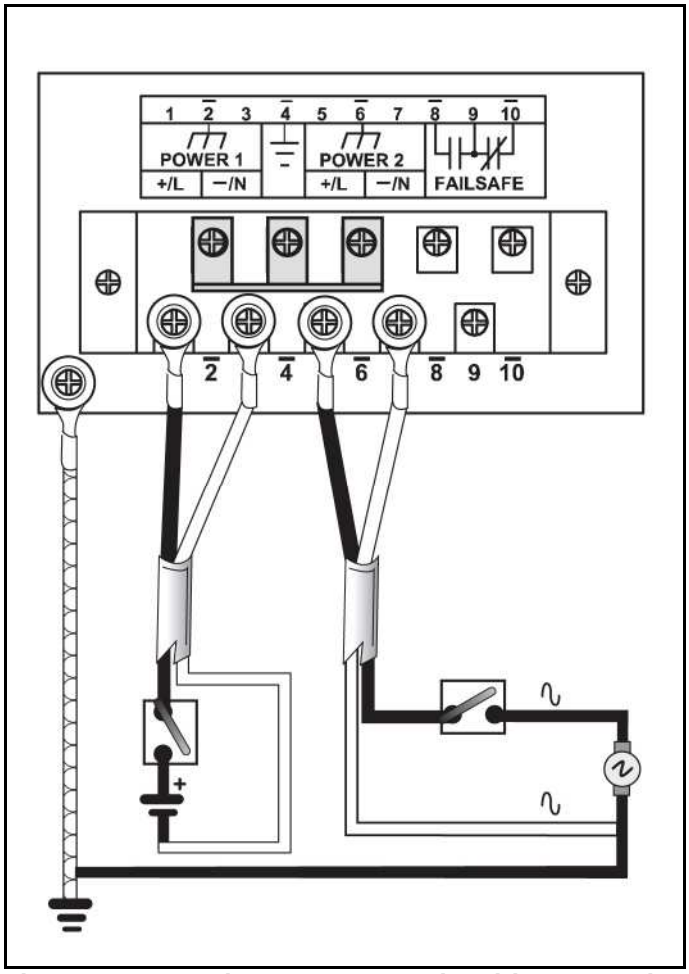


Figure 12: DC and AC Power Supply Wiring Examples

NOTES:

1. 88-300VDC rated equipment: A 300VDC appropriately rated circuit breaker must be installed.
2. 100-240VAC rated equipment: A 250VAC appropriately rated circuit breaker must be installed.
3. A circuit breaker is not required for 12, 24 or 48 VDC rated power supplies.
4. Separate circuit breakers must be installed and separately identified.
5. Equipment must be installed according to the applicable country wiring codes.

2.2.4 Dual Power Supplies – AC Input and 48VDC for PoE

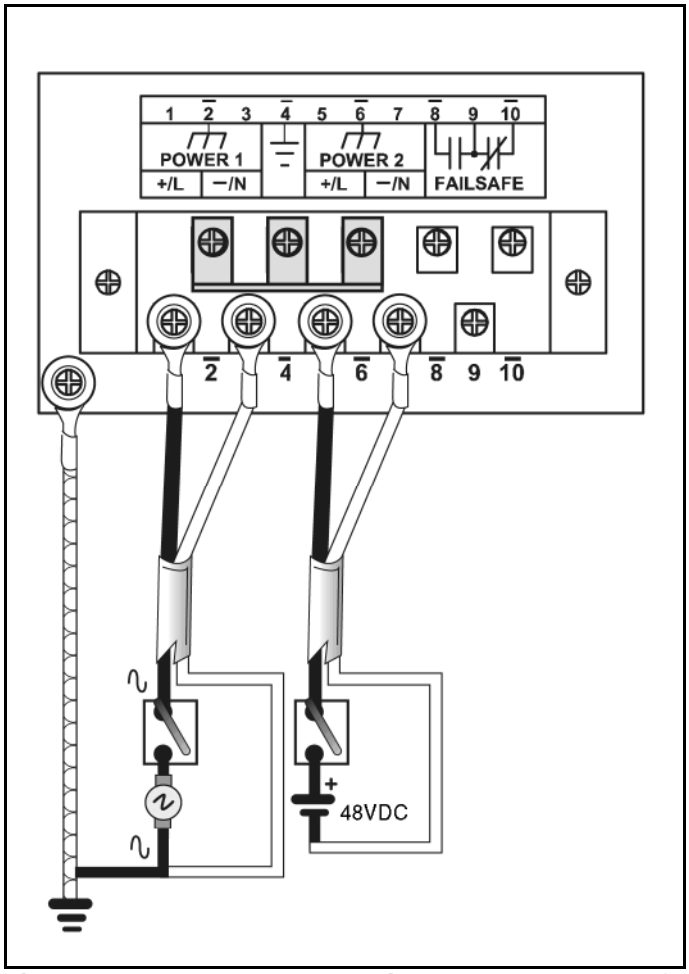


Figure 13: AC Input to PS1 and 48VDC Input to PS2 for PoE

NOTES:

1. 100-240VAC rated equipment: A 250VAC appropriately rated circuit breaker must be installed.
2. A circuit breaker is not required for 48VDC rated power supplies.
3. Equipment must be installed according to the applicable country wiring codes.

2.3 Dielectric Strength (HIPOT) Testing

For dielectric strength (HIPOT) testing in the field, users must remove the metal jumper located on terminal 2, 4, and 6 of the power supply terminal block. This metal jumper connects transient suppression circuitry to chassis ground and must be removed in order to avoid damage to transient suppression circuitry during HIPOT testing. Figure 14 shows the proper HIPOT test connections and should be followed to avoid damage to the device.

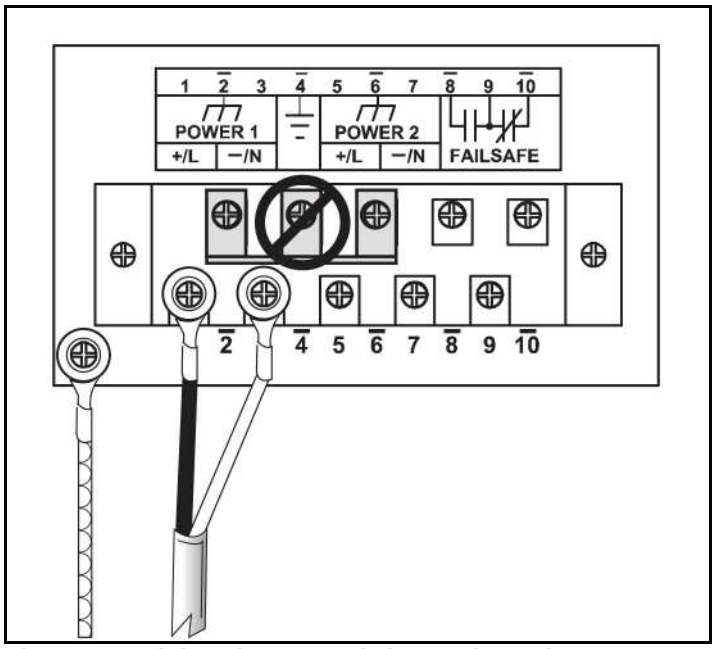


Figure 14: Dielectric Strength (HIPOT) Testing

2.4 Failsafe Alarm Relay Wiring

The “Failsafe” output relay is provided to signal critical error conditions that may occur on the RS416. The contacts are energized upon power up of the unit and remain energized until a critical error occurs. The proper relay connections are shown in Figure 15. A common application for this output is to signal an alarm if a power failure or removal of control power occurs. The failsafe relay current and power handling capabilities are specified in section 6.2 - Failsafe Relay Contact Ratings.

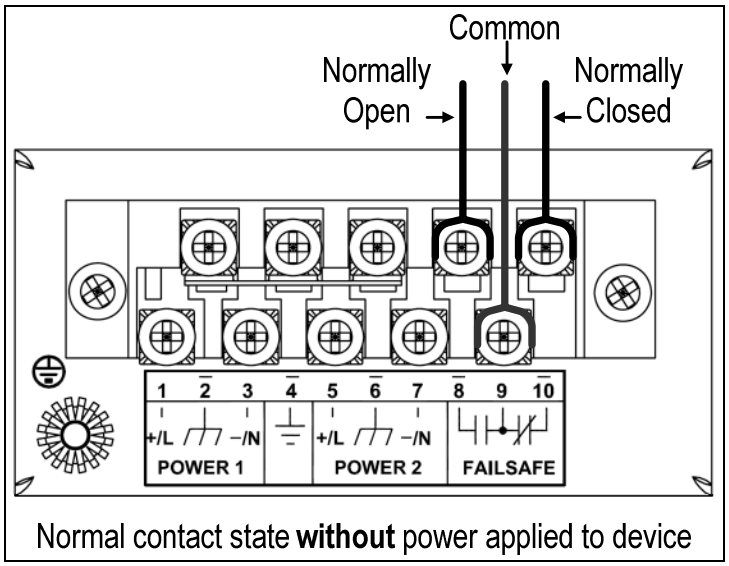


Figure 15: Failsafe Alarm Relay Wiring

2.5 Console Port Wiring

An RS232 console port for configuration and management of the device is located on the LED display module shown in Figure 16. This port is intended to be a temporary connection during initial configuration or troubleshooting and allows for direct access to the serial-based management console. The connection is made using the DB9-Female to RJ45 console cable included in the device packaging shown below. Console connection settings are 57600 baud, no parity bits, 8 data bits, and 1 stop bit.

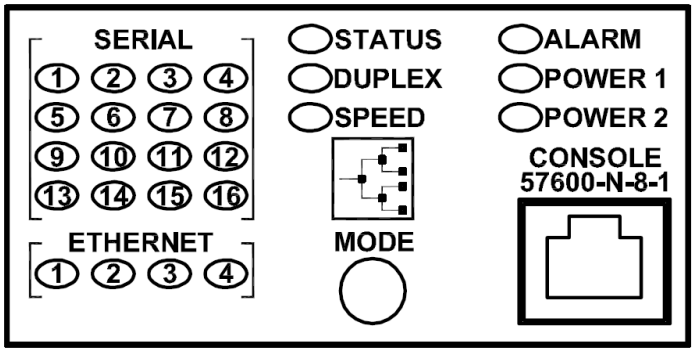


Figure 16: Console port location on display board

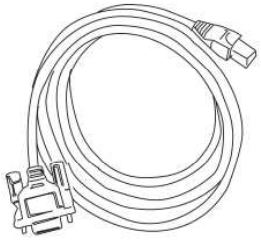


Figure 17: Console cable

For user reference, the console cable pin-out is show in the table below.

RuggedCom RS232 over RJ45 pin-out specification		
Signal Name (PC is DTE)	*Female DB9*	*Male RJ45*
DCD – Carrier detect	1	2
TxD – Transmit Data	2	5
RxD – Receive Data	3	6
DTR – Data terminal ready	4	3
Signal GND	5	4
DSR – Data set ready	6	1*
RTS – Ready to send	7	8
CTS – Clear to send	8	7
RI – Ring Indicator	9	1*

Table 5: RS232 over RJ45 console cable pin-out

After initial configuration, the RS416 can be configured via a number of mechanisms such as Telnet, and the built-in web server. Consult the RuggedSwitch ROS User Guide for further details.

NOTE: This port is not intended to be a permanent connection and the cable shall be less than 2m (6.5 ft) in length.

3 Serial Ports

The RS416 can be equipped with a Fiber Serial Interface, RS232/RS485/RS422 DB9 serial ports or RS232/RS485/RS422 RJ45 serial ports. DB9 and RJ45 ports may optionally be ordered with support for IRIG B time code. RS416 serial ports are designed with a high degree of isolation. DB9 and RJ45 ports feature isolation of all external signals. Serial port common ground terminals are connected to chassis ground via transient voltage protection circuitry.

3.1 Fiber Serial Interface

The RS416 can be equipped with a Fiber Serial Interface (ST connector only) which allows RS485, RS422, or RS232 devices to communicate over secure, noise immune, optically isolated, fiber optic cabling at extended distances as well as protocol independent conversion to multimode fiber optics.

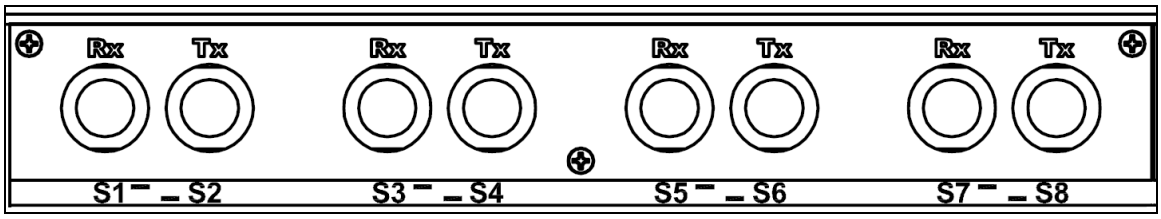


Figure 18: Fiber Serial Interface (ST Connector)

3.2 RS232/RS485/RS422 via DB9

Each port is individually selectable via software to be RS232, RS485 or RS422. The DB9 port pin-out diagram and listing are shown below.

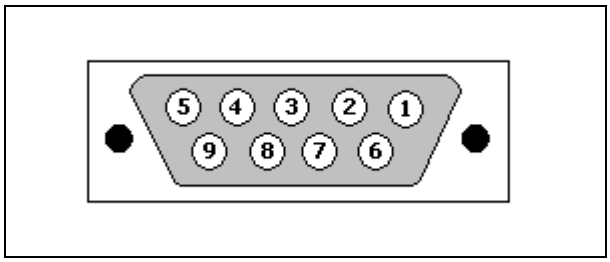


Figure 19: DB9 female port pin-out

Pin	RS232 DCE Mode	RS485 Mode	RS422 Mode
1	DCD[2]	-	-
2	TX[4]	TX/RX+	TX+
3	RX[4]	-	RX+
4	DTR[2]	-	-
5	Common (Isolated) Ground		
6	DSR[2]	-	RX-
7	RTS[2]	TX/RX-	TX-
8	CTS[2]	-	-
9	RI[3]	-	-
Shield	Chassis Ground		

Table 6: DB9 Female DCE Port pin-out

NOTES:

1. No internal termination is provided.
2. In RS232 mode, pins 1, 4, and 6 are connected internally, and pins 7 and 8 are connected internally. These pins enter a high impedance state. A DTE that asserts DTR and expects DSR or DCD will operate correctly. A DTE that asserts RTS will see CTS asserted, although the RuggedServer will not perform hardware flow control.
3. RI is not connected
4. In RS232 DCE mode, ports transmit to DTE devices on pin 2 and receive from DTE on pin 3.

3.3 RS232/RS485/RS422 plus IRIG-B via DB9

Each port is individually selectable via software to be RS232, RS485 or RS422. IRIG-B signal and ground are available on pins 4 and 6, respectively, for every mode. The DB9 port pin-out diagram and listing are shown below.

NOTE: The RS232 pin configuration of the IRIG-B ports is DTE rather than DCE, meaning that the port transmits on pin 3 and receives on pin 2. Connection to DTE ports requires null-modem cabling (pin 2 to 3; pin 3 to 2).

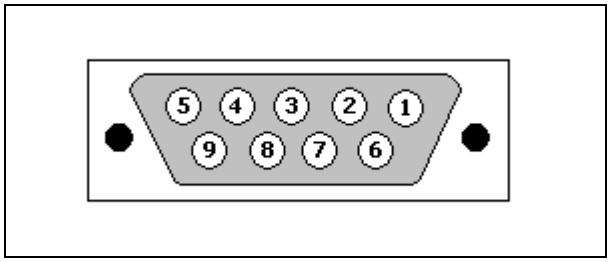


Figure 20: DB9 female port pin-out

Pin	RS232 DTE Mode	RS485 Mode	RS422 Mode
1	-	-	RX-
2	RX[3]	TX/RX+	TX+
3	TX[3]	-	RX+
4	+IRIG-B		
5	Common (Isolated) Ground		
6	Common (Isolated) Ground		
7	RTS[2]	TX/RX-	TX-
8	CTS[2]	-	-
9	Common (Isolated Ground)[3]		
Shield	Chassis Ground		

Table 7: DB9 Female DTE Port pin-out with IRIG-B

NOTES:

1. No internal termination is provided.
2. In RS232 mode, pins 7 and 8 are connected internally. These pins enter a high impedance state. A DCE that asserts RTS will see CTS asserted, although the RuggedServer will not perform hardware flow control.
3. In RS232 DTE mode, ports receive on pin 2 and transmit on pin 3.

The IRIG-B output on each port is configurable via software to provide IRIG-B pulse-width modulated output (IRIG-B006 or IRIG-B007) or PPS output, a single pulse per second on the second.

3.4 RS232/RS485/RS422 via RJ45

Each port is individually selectable via software to be RS232 (EIA-561 DTE), RS485 or RS422. The RJ45 port and pin-out is shown below.

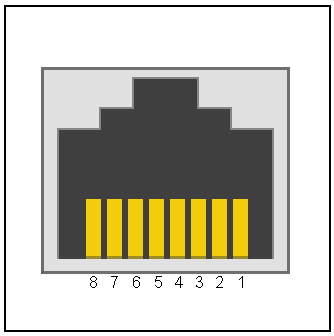


Figure 21: RJ45 port pin-out

Pin	RS232 Mode	RS485 Mode	RS422 Mode
1	DSR[2]	-	RX-
2	DCD[2]	-	-
3	DTR[2]	-	-
4	Common (Isolated) Ground		
5	RXD[3]	-	RX+
6	TXD[3]	TX/RX +	TX +
7	CTS[2]	-	-
8	RTS[2]	TX/RX -	TX -
Shield	Chassis Ground		

Table 8: RJ45 Port pin-out

NOTES:

1. No internal termination is provided.
2. Pins 1, 2, and 3 are connected internally. Pins 7 and 8 are connected internally. In RS232 mode, these pins enter a high impedance state. A DTE that asserts DTR and expects DSR or DCD will operate correctly. A DTE that asserts RTS will see CTS asserted, although the RuggedServer will not perform hardware flow control.
3. In RS232 mode, the RJ45 ports conform to EIA-561 DTE, which transmit on TXD and receive on RXD.

3.5 RS232/RS485/RS422 plus IRIG-B via RJ45

Each port is individually selectable via software to be RS232, RS485 or RS422. IRIG-B signal and ground are available on pins 2 and 3, respectively, for every mode. The RJ45 port and pin-out is shown below.

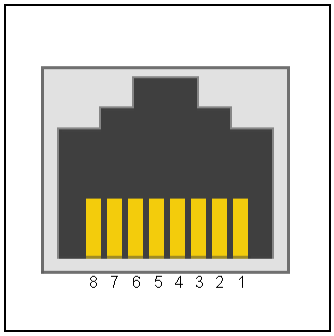


Figure 22: RJ45 port pin-out with IRIG-B

Pin	RS232 Mode	RS485 Mode	RS422 Mode
1	-	-	RX-
2	+IRIG-B		
3	Common (Isolated) Ground		
4	Common (Isolated) Ground		
5	RXD[3]	-	RX+
6	TXD[3]	TX/RX +	TX +
7	CTS[2]	-	-
8	RTS[2]	TX/RX-	TX-
Shield	Chassis Ground		

Table 9: RJ45 Port pin-out

NOTES:

1. No internal termination is provided.
2. Pins 7 and 8 are connected internally. In RS232 mode, these pins enter a high impedance state. A DTE that asserts RTS will see CTS asserted, although the RuggedServer will not perform hardware flow control.
3. In RS232 mode, the RJ45 ports conform mostly to EIA-561 DTE, which transmit on TXD and receive on RXD.

The IRIG-B output on each port is configurable via software to provide IRIG-B pulse-width modulated output (IRIG-B006 or IRIG-B007) or PPS output, a single pulse per second on the second.

3.6 RS485 Wiring

Each RS485 port can communicate to multiple RS485 devices by daisy chaining devices over a single twisted pair with transmit and receive signals on the same two wires (half duplex). The following guidelines should be followed to ensure reliable continuous communication:

1. To minimize the effects of ambient electrical noise, shielded cabling is recommended.
2. The correct polarity must be observed throughout a single daisy chain.
3. The number of devices wired should not exceed 32, and total distance should be less than 4000 feet (at 100 kbps).
4. The Common terminals should be connected to the common wire inside the shield.
5. The shield should be connected to earth ground at a single point to avoid loop currents
6. The twisted pair should be terminated at each end of the chain.

The figure below shows the recommended RS485 wiring.

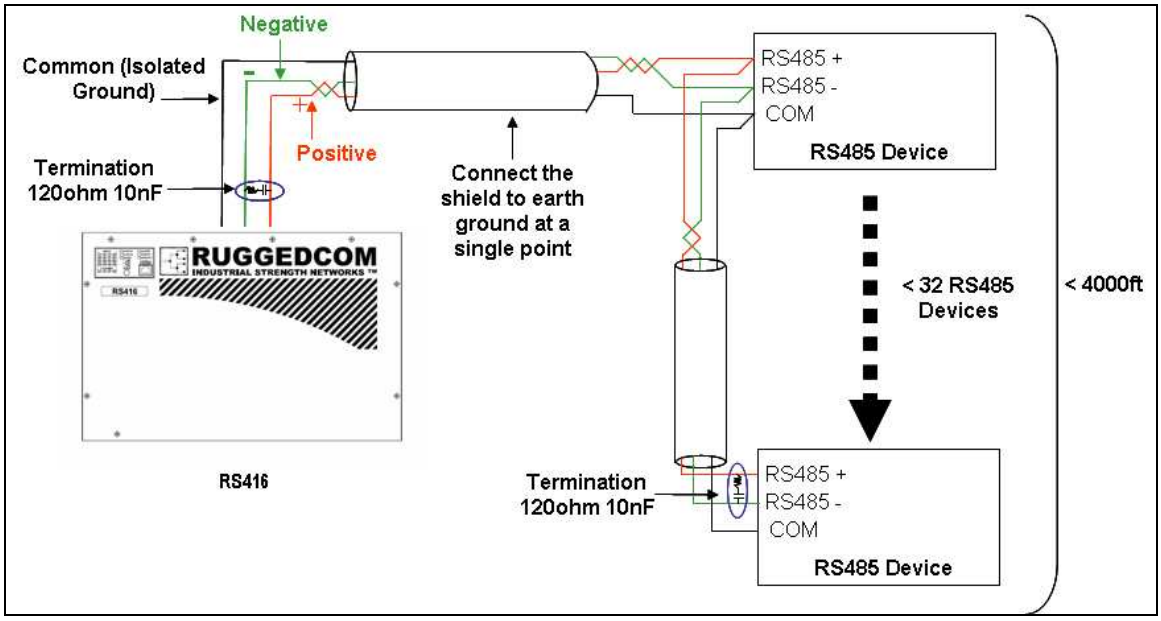


Figure 23: Conceptual recommended RS485 wiring diagram

3.7 Serial Port Transient Protection

RuggedCom does not recommend the use of copper cabling of any length for critical real-time substation automation applications. However, transient suppression circuitry is present on all copper ports to protect against damage from electrical transients and to ensure IEC 61850-3 and IEEE 1613 Class 1 conformance. This means that during the transient event communications errors or interruptions may occur but recovery is automatic.

RuggedCom also does not recommend using these ports to interface to field devices across distances which could produce high levels of ground potential rise, (i.e. greater than 2500V) during line to ground fault conditions.

4 Time Synchronization

The RS416 is able to derive and provide time synchronization via Ethernet using the Precision Time Protocol (PTP - IEEE1588v2) and NTP (Network Time Protocol).
With the IRIG-B module is installed, the RS416 is also able to synchronize to received IRIG-B time signal and to distribute it via BNC and via serial ports equipped with IRIG-B signals. Please refer to the data sheet for ordering options.

Table 10, below, lists all the external sources that may be used by the RS416 for time synchronization.

Synchronization Source	***Without IRIG Module***	***With IRIG Module***
NTP	✓	✓
IEEE 1588 v2	✓	✓
IRIG-B PWM		✓

Table 10: RS416 Time Synchronization Sources

Table 11, below, summarizes the time synchronization services that the RS416 is able to provide.

Synchronization Service	***Without IRIG Module***	***With IRIG Module***
NTP	✓	✓
IEEE 1588 v2	✓	✓
IRIG-B PWM		✓

Table 11: RS416 Time Synchronization Services

NTP (Network Time Protocol) is the standard for synchronizing the clocks of computer systems throughout the Internet and is suitable for systems that require accuracies on the order of 1 ms.

IRIG-B (Inter Range Instrumentation Group, mod B) time synchronization is an established, inter-device time synchronization mechanism which provides accuracy on the order of 1ms to 1µs.

IEEE 1588 is designed to fill a niche not well served by either NTP or IRIG-B. IEEE1588 is designed for local systems requiring accuracies on the order of 100 nanoseconds. IEEE 1588 is also designed for applications that cannot bear the cost of a GPS receiver at each node or for which GPS signals are inaccessible. Every Ethernet port on the RS416 supports IEEE1588.

4.1 IRIG-B Ports

The IRIG-B output ports described in sections 3.3 and 3.5 derive their time from the IRIG-B module, which occupies one slot in lieu of a two-port Ethernet module. The IRIG-B module has one dedicated input and one dedicated output. These ports operate in IRIG-B PWM mode (IRIG-B006 or IRIG-B007) only.

Figure 24 shows layout of the BNC connectors on the IRIG-B I/O board. The LED in the center of the board, indicated by the mark, reflects the status of the received IRIG-B signal, and is described in Table 12.

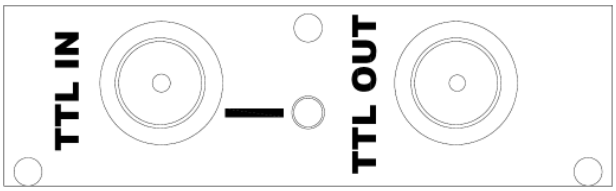


Figure 24: IRIG-B daughter board BNC connections

LED Color	*Meaning*
Off	No IRIG-B signal detected
Red	Errors detected in received IRIG-B signal
Green	Received IRIG-B signal is good

Table 12: IRIG-B Daughter Board LED

4.2 IRIG-B Connection Considerations

The number of IRIG-B devices that can be connected to a given IRIG-B output is dependent on the cabling type and length as well as the input impedances of connected devices. Figure 25 shows a simplified circuit diagram of the interface between an IRIG-B output and connected devices.

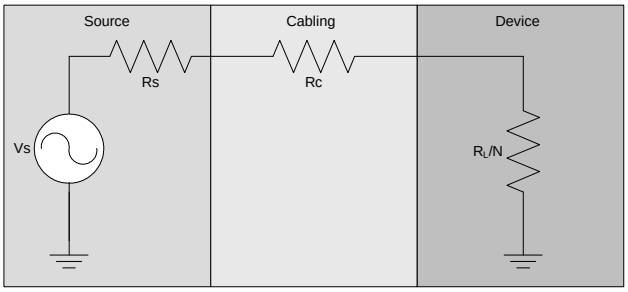


Figure 25: IRIG-B Output Simplified Schematic

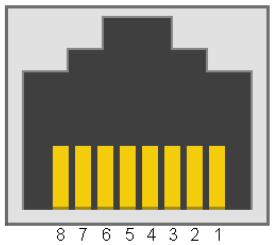
The maximum number of devices (N) that can be connected to the source is determined by verifying that the source current (I_S) required to drive the connected devices is less than the maximum drive current the output can provide, and that the load voltage (V_L) seen by the connected devices is greater than their minimum required voltage. Refer to section 6.3.2 for IRIG-B port specifications.

5 Ethernet Ports

5.1 Copper Ports

The RS416 may have up to 4 10/100BaseTX ports that allow connection to standard CAT-5 UTP cable with RJ45 male connectors. All RJ45 Ethernet ports feature auto-

negotiating, auto-polarity, and auto-crossover functions. On the RS416P, these ports support PoE, providing up to 15.4W per port at a nominal 48VDC, auto-sensing and auto-power off when cables are disconnected. The RJ45 receptacles can also accept and take advantage of screened (commonly known as “shielded”) cabling. Figure 26 shows the RJ45 port pins configuration.



Pin	Signal
1	+Rx
2	-Rx
3	+Tx
4	No Connection
5	No Connection
6	-Tx
7	No Connection
8	No Connection

Figure 26: RJ45 port pins configuration.

NOTE: RuggedCom does not recommend the use of copper cabling of any length for critical real-time substation automation applications. However, transient suppression circuitry is present on all copper ports to protect against damage from electrical transients and to ensure IEC 61850-3 and IEEE 1613 Class 1 conformance. This means that during the transient event communications errors or interruptions may occur but recovery is automatic. RuggedCom also does not recommended to use these ports to interface to field devices across distances which could produce high levels of ground potential rise, (i.e. greater than 2500V) during line to ground fault conditions.

5.2 Fiber Optic Ports

Depending on the order code of the product, the RS416 can be equipped with several different types of fiber optic ports. The Transmit (TX) and Receive (RX) connections of each port must be properly connected and matched for proper link and operation. Modules populated on the top row of the device typically have locking mechanisms or tabs towards the top of the unit. Modules located on the bottom row of the device have locking mechanisms or tabs towards the bottom of the device.

The drawings in the following figures show each fiber optical connector style with a side and top view to allow the user to identify the proper cable connection orientation. If modules are populated on the bottom row of the device, the transceiver orientation will be reversed (i.e. RX and TX will be reversed).

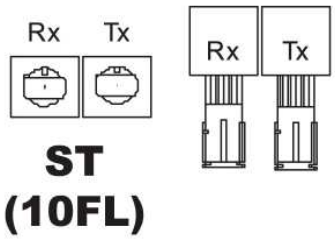


Figure 27: 10FL ST connector

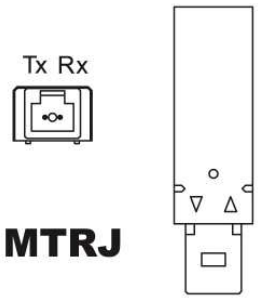


Figure 28: 100FX MTRJ connector

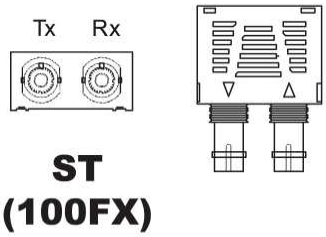


Figure 29: 100FX ST connector

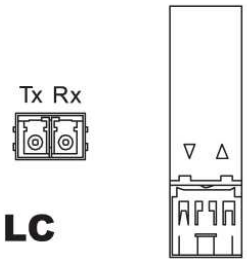


Figure 30: 100FX LC connector

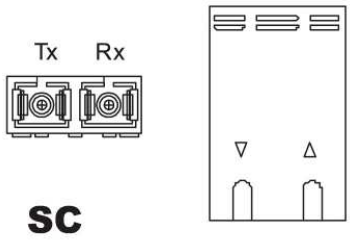


Figure 31: 100FX SC connector

5.3 Ethernet Panel Description

Each Ethernet module is equipped with two LEDs that indicate link/activity status information. The LED will be solid for ports with link, and will blink for activity. The diagram in Figure 32 highlights the port and the associated link/activity LED.

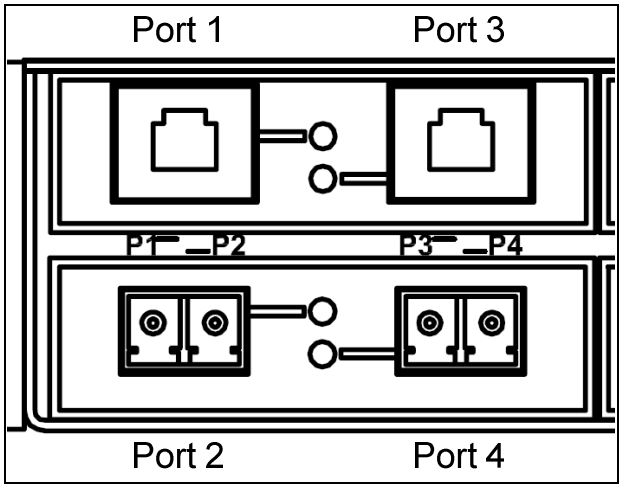


Figure 32: Ethernet panel LED description

6 Technical Specifications

6.1 Power Supply Specifications

Power Supply Type[4]	Input Range		Internal Fuse Rating	Max. Power Consumption[3]
	Min	Max		
12 – 24 VDC	10 VDC	36 VDC	6.3A(F) [2]	15 W
48 VDC	36 VDC	59 VDC	3.15A(T) [2]	
HI (125/250 VDC) [1] HI (110/230 VAC) [1]	88 VDC 85 VAC	300 VDC 264 VAC	2A(T) [1,2]	

Table 13: Main Power Supply Specifications

Power Supply Type (PS2) [4]	Input Range		Internal Fuse Rating	Maximum Power Consumption
	Min	Max		
48 VDC	37 VDC	72 VDC	2A(T)[2]	68 W

Table 14: PoE Power Supply Specifications

NOTES:

1. This is the same power supply for both AC and DC.
2. (F) Denotes fast-acting fuse, (T) denotes time-delay fuse.
3. Power consumption varies based on configuration. 10/100Tx ports consume roughly 1W less than fiber optic ports
4. RS416 can use the Main Power Supply for PS1 and optionally PS2. RS416P uses the Main Power Supply in PS1 only and the PoE Power Supply in PS2 only.

6.2 Failsafe Relay Contact Ratings

Parameter	Value (Resistive Load)
Max Switching Voltage	240VAC, 125VDC
Rated Switching Current	2A @ 240VAC 0.15A @ 125VDC, 2A @ 30VDC
Max Switching Capacity	150W, 500VA

Table 15: Failsafe Relay Contact Ratings

6.3 Data Port Specifications

6.3.1 Serial Ports

6.3.1.1 Copper Ports

Parameter	Specifications	Notes
Baud Rate	300 bps – 230 kbps	
Connector	DB9 or RJ45	
Isolation	2.5 kV	RMS 1-minute

Table 16: Copper Port Specification

6.3.1.2 Fiber Optic Ports

Parameter	Specifications
Mode	Multimode
Connector	ST
Typical Dist. (km)	5
Optical Wavelength (nm)	820
Cable Size Core/Cladding (um)	50/125 62.5/125

Table 17: Fiber Optic Port Specification

NOTES:

1. Maximum segment length is greatly dependent on factors such as fiber quality, and number of patches and splices. Please consult RuggedCom sales associates when determining maximum segment distances.

6.3.2 IRIG-B Ports

Parameter	Typical Value
Input Voltage	TTL-Compatible
Input Impedance	> 200 kΩ

Table 18: IRIG-B PWM Input

Parameter	Typical Value
Output Current (I_S)	100 mA
Output Voltage (V_S)	5 V_{p-p}
Output Impedance (R_S)	50 Ω

Table 19: IRIG-B Port Output Specifications

6.3.3 Ethernet Ports

6.3.3.1 Copper Ports

Parameter	Specification	Notes
Speed	10/100 Mbps	Auto-negotiating
Duplex	FDX / HDX	Auto-negotiating
Cable-Type	> Category 5	Shielded/Unshielded
Wiring Standard	TIA/EIA T568A/B	Auto-Crossover, Auto-polarity
Max Distance	100 m	
Connector	RJ45	
Isolation	1.5 kV	RMS 1-minute
PoE Voltage	44-57 V	
PoE Current	350 mA	

Table 20: Ethernet Ports - Copper Specifications

6.3.3.2 Fiber Optic Ports

The following sections detail fiber optic specifications on ports that can be ordered with the RS416. The user determines the type of optics at time of ordering and can determine the modules installed on a particular unit by reading the factory data file via the ROS™ user interface. The following section provides detailed specifications of fiber optic modules.

The dual-port fast Ethernet optical specifications for slots 5 and 6 are shown in **Error! Reference source not found.** organized by module order code. Module order codes are contained within each product's factory data when assembled and configured at the factory. Consult ROS™ to determine the optical assemblies installed in a particular product.

Optics Order Code	Speed Standard	Mode / Connector	Tx (nm)	Cable Type (um)	Tx min (dBm)	Tx max (dBm)	Rx Sensitivity (dBm)	Rx Saturation (dBm)	Typical Distance (km)	Power Budget (dB)
12-11-0011	10FL	MM/ST	820	62.5/125 50/125	-16 -19.8	-9 -12.8	-34 -34	-11.2 -11.2	2 2	18 14.2
12-11-0012	10FL	SM/ST	1310	9/125	-27	-14	-35	-3	5	8
12-11-0007	100FX	MM/ST	1300	62.5/125 50/125	-19 -22.5	-14 -14	-33.9 -33.9	-14 -14	2 2	14.9 11.4
12-11-0009	100FX	MM/SC	1300	50/125 62.5/125	-22.5 -19	-14 -14	-33.9 -33.9	-14 -14	2 2	11.4 14.9
12-11-0008	100FX	MM/MTRJ	1300	50/125 62.5/125	-22.5 -19	-14 -14	-33.5 -33.5	-14 -14	2 2	11 14.5
12-11-0046	100FX	MM/LC	1310	62.5/125	-19	-14	-32	-14	2	13

12-11-0006	100FX	SM/ST	1310	9/125	-15	-7	-34	-3	20	19
12-11-0005	100FX	SM/SC	1300	9/125	-15	-8	-31	-7	20	16
12-11-0004	100FX	SM/LC	1300	9/125	-15	-8	-38	-3	20	23
12-11-0031	100FX	SM/SC	1310	9/125	-5	0	-34	-3	50	29
12-11-0032	100FX	SM/LC	1310	9/125	-5	0	-35	-3	50	30
12-11-0033	100FX	SM/SC	1310	9/125	0	5	-37	0	90	42
12-11-0034	100FX	SM/LC	1310	9/125	0	5	-37	0	90	37

Table 21: Ethernet Ports – Fiber Optic Specifications

NOTES:
Maximum segment length is greatly dependent on factors such as fiber quality, and number of patches and splices. Please consult RuggedCom sales associates when determining maximum segment distances.

1. All optical power numbers are listed as dBm averages.
2. All cabling is duplex type unless otherwise specified.
3. These transceivers utilize a distributed feedback (DFB) type laser and are rated for -20°C to +85°C operation only.

6.4 Operating Environment

Parameter	***Range***	***Comments***
Ambient Operating Temperature	-40 to 85°C	Ambient Temperature as measured from a 30cm radius surrounding the center of the RS1600 enclosure.
Ambient Relative Humidity	5% to 95%	Non-condensing
Ambient Storage Temperature	-40 to 85°C	

Table 22: Operating Environment

6.5 Mechanical Specifications

Parameter	Value	Comments
Dimensions	18.29 x 10.17 x 1.74 inches (464,57) x (258,32) x (44,20) mm	(Length x Width x Height) with mounting brackets installed
Weight	10 lb (4.5 Kg)	
Enclosure	18 AWG galvanized steel	

Table 23: Mechanical Specifications

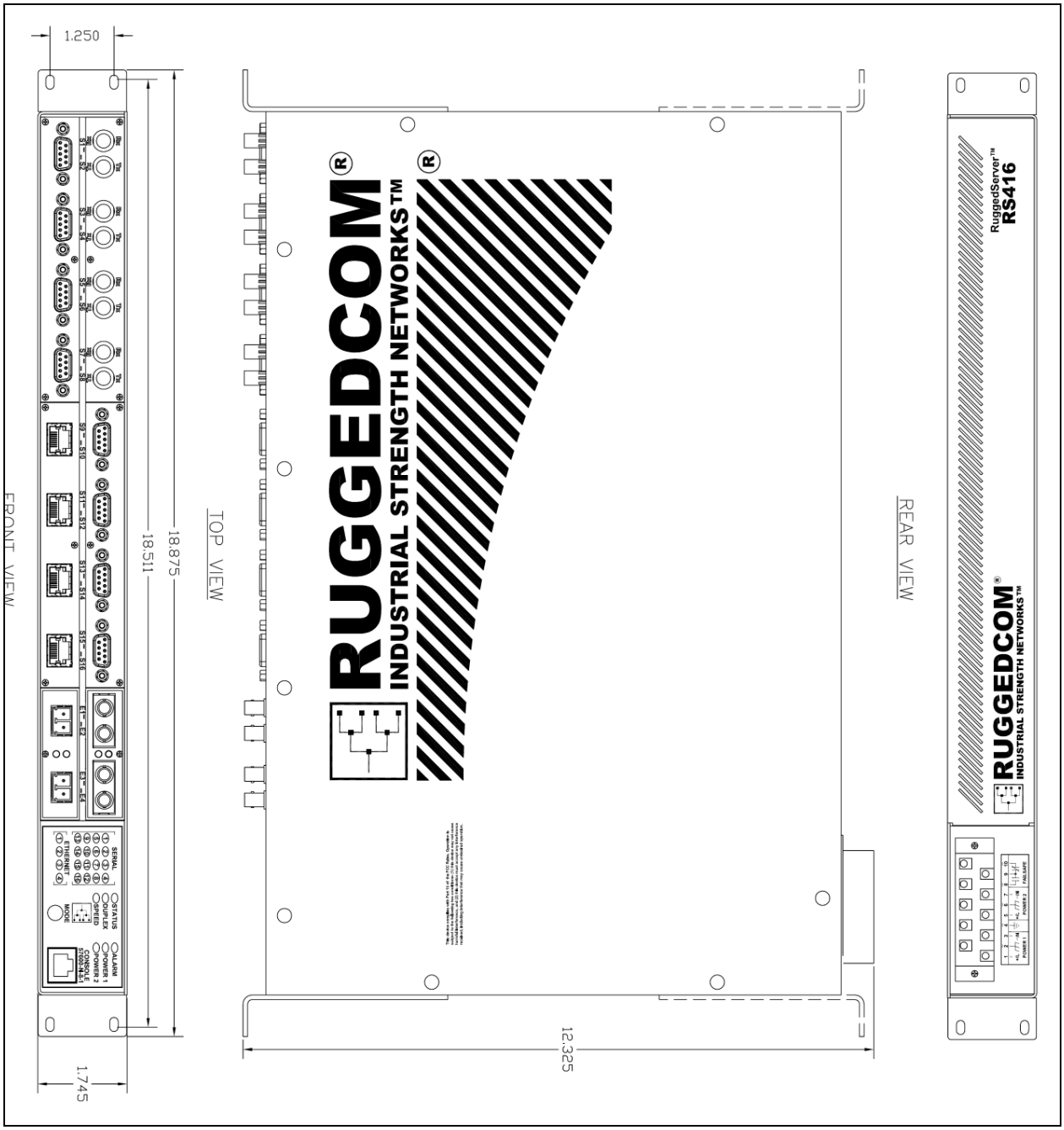


Figure 33: Mechanical Drawing

7 Type Tests

7.1 IEC 61850-3 Type Tests

Test	Description		Test Levels	Severity Levels
IEC 61000-4-2	ESD	Enclosure Contact	+/- 8kV	4
		Enclosure Air	+/- 15kV	4
IEC 61000-4-3	Radiated RFI	Enclosure ports	20 V/m	Note 1
IEC 61000-4-4	Burst (Fast Transient)	Signal ports	+/- 4kV @ 2.5kHz	Note 1
		D.C. Power ports	+/- 4kV	4
		A.C. Power ports	+/- 4kV	4
		Earth ground ports	+/- 4kV	4
IEC 61000-4-5	Surge	Signal ports	+/- 4kV line-to-earth, +/- 2kV line-to-line	4
		D.C. Power ports	+/- 2kV line-to-earth, +/- 1kV line-to-line	3
		A.C. Power ports	+/- 4kV line-to-earth, +/- 2kV line-to-line	4
IEC 61000-4-6	Induced (Conducted) RFI	Signal ports	10V	3
		D.C Power ports	10V	3
		A.C. Power ports	10V	3
		Earth ground ports	10V	3
IEC 61000-4-8	Magnetic Field	Enclosure ports	40 A/m continuous, 1000 A/m for 1 s	Note 1
			1000 A/m for 1 s	5
IEC 61000-4-29	Voltage Dips & Interrupts	D.C. Power ports	30% for 0.1s, 60% for 0.1s, 100% for 0.05s	N/A
		A.C. Power ports	30% for 1 period, 60% for 50 periods	N/A
IEC 61000-4-11			100% for 5 periods, 100% for 50 periods [2]	N/A
IEC 61000-4-12	Damped Oscillatory	Signal ports	2.5kV common, 1kV differential mode @ 1MHz	3
		D.C. Power ports	2.5kV common, 1kV differential mode @ 1MHz	3
		A.C. Power ports	2.5kV common, 1kV differential mode @ 1MHz	3
IEC 61000-4-16	Mains Frequency Voltage	Signal ports	30V Continuous, 300V for 1s	4
		D.C. Power ports	30V Continuous, 300V for 1s	4
IEC 61000-4-17	Ripple on D.C. Power Supply	D.C. Power ports	10%	3
IEC 60255-5	Dielectric Strength	Signal ports	2kV AC (Fail-Safe Relay output)	N/A
		D.C. Power ports	1.5kVDC	N/A
		A.C. Power ports	2kVAC	N/A
IEC 60255-5	H.V. Impulse	Signal ports	5kV (Fail-Safe Relay output)	N/A
		D.C. Power ports	5kV	N/A
		A.C. Power ports	5kV	N/A

Table 24 - IEC 61850-3 Type Tests

Note 1: Ruggedcom specified severity levels

7.2 IEEE 1613 Type Tests

IEEE Test	IEEE 1613 Clause	Description		Test Levels
C37.90.3	9	ESD	Enclosure Contact	+/- 8kV
			Enclosure Air	+/- 15kV
C37.90.2	8	Radiated RFI	Enclosure ports	35 V/m
C37.90.1	7	Fast Transient	Signal ports	+/- 4kV @ 2.5kHz
			D.C. Power ports	+/- 4kV
			A.C. Power ports	+/- 4kV
			Earth ground ports	+/- 4kV
C37.90.1	7	Oscillatory	Signal ports	2.5kV common mode @ 1MHz
			D.C. Power ports	2.5kV common & differential mode @ 1MHz
			A.C. Power ports	2.5kV common & differential mode @ 1MHz
C37.90	6	H.V. Impulse	Signal ports	5 kV (Failsafe Relay)
			D.C. Power ports	5 kV
			A.C. Power ports	5 kV
C37.90	6	Dielectric Strength	Signal ports	2kVAC
			D.C. Power ports	1.5kVDC
			A.C. Power ports	2kVAC

Table 25 - IEEE 1613 Type Tests

Notes:

- If the unit contains copper ports, the IEEE 1613 conformance is Class 1 (During disturbance, errors may occur but recovery is automatic).
- If the unit contains all fiber ports, the IEEE 1613 conformance is Class 2 (During disturbance, no errors will occur).

7.3 IEC Environmental Type Tests

Test	Description		Test Levels	Severity Levels
IEC 60068-2-1	Cold Temperature	Test Ad	-40 deg. C, 16 Hours	N/A
IEC 60068-2-2	Dry Heat	Test Bd	+85 deg. C, 16 Hours	N/A
IEC 60068-2-30	Humidity (Damp Heat, Cyclic)	Test Db	95% (non-condensing), 55°C, 6 cycles	N/A
IEC 60255-21-1	Vibration		2g @ (10-150) Hz	Class 2
IEC 60255-21-2	Shock		30g @ 11 ms	Class 2

Table 26 - Environmental Type Tests

8 Agency Approvals

Agency	Standards	Comments
CSA	CSA C22.2 No. 60950, UL 60950	Approved
CE	EN 60950, EN 61000-6-2	Approved
FCC	FCC Part 15, Class A	Approved
CISPR	EN55022, Class A	Approved
FDA/CDRH	21 CFR Chapter 1, Subchapter J	Compliant
IEC/EN	EN60825-1:1994 + A11:1996 + A2:2001	Compliant

Table 27: Agency Approvals

9 Warranty

RuggedCom warrants this product for a period of five (5) years from date of purchase. For warranty details, visit http://www.ruggedcom.com or contact your customer service representative.

Should this product require warranty or service contact the factory at:

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